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Happiness and Sex Difference in Life Expectancy

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Abstract

This paper examines the effects of happiness on the sex gap in life expectancy. Utilizing a cross-country data set, it first inspects the reverse effect of the life expectancy gap on happiness and demonstrates that the life expectancy gap negatively affects happiness through the composition of marital status. Taking this reverse causality into account, it shows that happiness is significant on explaining the differences in the life expectancy gap between countries. As national average happiness increases, the sex difference in life expectancy decreases. This is consistent with the findings that psychological stress (unhappiness) adversely affects survival and that the effect of psychological stress on mortality is more severe for men. This result provides an indirect evidence that happiness affects survival even at the national aggregate level.

Keywords: happiness; life expectancy

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1 Introduction

Happiness and health are correlated. Utilizing micro data sets, a number of studies have reported both that health status influences the feeling of happiness (e.g., Diener, Suh, Lucas and Smith, 1999; Frey and Stutzer, 2002; Helliwell, 2003; Borooah, 2006), and also that happy individuals live longer (see Pressman and Cohen, 2005; Veenhoven, 2008, for reviews).

This relationship has also been examined at the aggregate level, utilizing national life expectancy as a proxy for the health of particular countries. Ovaska and Takashima (2006) and Deaton (2008) for example both found that life expectancy is an important factor explaining the differences in national levels of life satisfaction between countries, while Bjørnskov (2008) by contrast found that happiness actually had a *negative* effect on life expectancy using a 2SLS approach.

That some studies model happiness as the dependent variable and health as the explanatory variable, while others model them the other way round, reflects the fact that the causality is not simple or unidirectional. Happiness affects health and health affects happiness, and both are further correlated with third variables such as income, lifestyle and education, leading to complex patterns of correlation which do not reflect simple patterns of causation. This not only renders the OLS estimator biased, but also makes it difficult to find appropriate instruments for 2SLS.

When comparisons between countries involve limited sample sizes and unbalanced panels, this complexity further hinders the analyses. Large numbers of explanatory variables reduce the efficiency of the regression models and especially when there are high levels of multicollinearity there may not be an analytical means to partition their separate effects.

To circumvent these problems but yet to find out whether the findings in micro studies that happier people live longer are still valid at the aggregate national level, the present study takes a different approach. It uses the sex difference in life expectancy (the difference between women and men) as the dependent variable, not the level of life expectancy.

Instead, the present study adopts the concept that women's and men's survival probabilities react differently to happiness (or unhappiness), which in turn depends on the findings that men are worse at coping with psychological stress than women.[1] Weidner and Cain (2003) for example suggest that the substantial increase in coronary heart disease observed in Eastern Europe after the fall of communism which resulted in the region's dramatic health deterioration is principally caused by psychosocial stress and that this has a bigger impact on men because men cope less effectively with stress.

The sex difference in the effect of psychosocial stress is, at least partially,

[1] This does not necessarily mean that the level of psychological stress is higher for men. On the contrary, women face a higher risk of depression. See e.g. Mirowsky and Ross (1995)

related to the sex difference in behavior. Möller-Leimkühler (2003) examined the sex gap in premature death due to a range of factors such as suicide, coronary heart disease, violence, accidents, drug or alcohol abuse and argues that traditional masculinity prevents men from seeking help and that this is the reason why men cope less effectively with psychological stress and adopt maladaptive strategies such as excessive alcohol consumption. These studies indicate that psychological stress directly and indirectly influences mortality and that its effect on mortality is more severe for men.

Speculating that happiness data reflect the level of psychological stress, being stressed as being unhappy, and that the sex difference in stress responsiveness influences the sex gap in life expectancy, the life expectancy gap is expected to increase as the national level of happiness decreases. This effect may be easier to capture than the effect of happiness on life expectancy itself at cross-country level since the sex difference in stress responsiveness may be rooted in biological factors and not vary substantially across countries. If this effect is captured, it can be interpreted as one indirect evidence of happiness influence on health at national aggregate level.

There are also technical advantages in using the life expectancy gap. One advantage is that the regression model can be kept relatively simple and that multicollinearity is less severe as we can drop variables that affect both sexes in a similar manner. Period dummies are good examples. Although life expectancy itself is expected to increase as time passes by due to technological progresses, no clear time trend is expected for the life expectancy gap after controlling for the level of life expectancy.

The advantage of reducing the number of explanatory variables is not confined to the efficiency gain. It can also reduce bias. In the case of period dummies, as the present study uses a heavily unbalanced panel, the inclusion of period dummies can possibly capture the sample bias that some countries, such as newly independent countries in a certain region, are omitted at some periods in non random manners. Therefore, dropping period dummies, if possible, would be beneficial in terms of both efficiency gain and bias reduction.

Another advantage stems from the simpler relationship between the life expectancy gap and happiness. As described above, happiness and life expectancy are intricately interrelated. In particular, the influence of life expectancy on happiness is expected to be widespread and substantial. On the other hand, the effect of the life expectancy gap on happiness is not expected to be so extensive. Its effect is primarily limited to the compositional effect of marital status, i.e., the indirect effect of the life expectancy gap on national average happiness through the composition of marital status. As the happiness level differs across marital statuses, the compositional adjustment in marital status associated with the change in the life expectancy gap affects national average happiness.

The remainder of this article is organized as follows. The next section discusses the sources of the life expectancy gap. Section 3 addresses the regression procedures, including the endogeneity problem, and section 4 presents the results. The details of data, such as the definitions, data sources, sample countries are presented in Appendix. By regressing the life expectancy gap on various variables, including the level of happiness and the sex gap in happiness (the difference between women and men), the main hypotheses to be tested are that (1) happiness affects the life expectancy gap negatively, and that (2) the happiness gap affects the life expectancy gap positively. The latter hypothesis is a simple reflection of the idea that happier individuals live longer. The results support the first hypothesis whereas the second hypothesis can not be confirmed. Section 5 concludes.

2 Sex Difference in Life Expectancy

Women live longer than men. The cross-country average of the life expectancy gap is about five years (UN, 2000-2005 data). This gap is considered to be related to both genetic-physiological and behavioral-social factors.

Genetic and physiological factors that possibly contribute to women's higher life expectancy include compensatory effects of the second X chromosome, longer telomeres, stronger immune systems, better protection against oxidative stress, and the protective effects of estrogens (Austad, 2006; Eskes and Haanen, 2007). These factors lower women's mortality risk, especially the one associated with cardiovascular disease.

There are also large differences across countries that can not be explained by genetic-physiological factors. For example, women's life expectancy in Russia exceeds men's life expectancy by 13.3 years whereas the gap is negative 0.46 years in Zimbabwe (UN, 2000-2005 data). The gap in life expectancy is also time-variant. It has been shrinking in many industrialized countries since the 1970s as life expectancy rises (Trovato and Heyen, 2006; Glei and Horiuchi, 2007).

These cross-society differences in life expectancy gap are attributed to behavioral and social factors. Behavioral factors include lifestyle, smoking, drug and alcohol consumption, violence, and accidents (Gjonça, Tomassini and Vaupel, 1999; McKee and Shkolnikov, 2001; Luy, 2003; Trovato, 2005; Phillips, 2006; Trovato and Heyen, 2006). Men tend to engage in these life-threatening behavior more often than women, and the actual intensity of these behavior is influenced by social factors such as social norms, political situations, and economic conditions. This suggests that the surrounding environment affects the life expectancy gap through behavioral factors.

Social factors also include the levels of resources, such as technological, economic, and medical resources, that can be invested in improving the general health condition of the population. They may affect women and men differently since women tend to utilize more resources for their health.

These various components are not necessarily mutually exclusive. In particular, both physiological and behavioral factors are considered to be evolutionarily rooted in sexual selection. They may simply be different aspects of expression of sexual dimorphism. At the physiological level, sexual size dimorphism is a good example. Males are physically larger than females in most species among mammals. As females become more choosy as their costs of reproduction become higher than their counterparts, male's reproductive success depends more on his physical size, and consequently, the force of natural selection has favored physically larger males. However, being larger comes with a cost, i.e., the higher mortality. Sexual size dimorphism and male-bias in mortality are positively associated among mammals (Promislow, 1992; Moore and Wilson, 2002; Clutton-Brock and Isvaren, 2007). Being larger results in being more frail.

In similar manners, sex differences in behaviors are related to sexual selection. For example, males tend to engage in risky behaviors more often than females. Due to the lower costs of reproduction, males that take risks and succeed (e.g., more chances of mating or more productive outputs) can possibly reproduce much more than the female counterparts. For instance, if a male succeeds in monopolizing multiple females, the reproductive return would increase substantially whereas monopolizing multiple males would not greatly enhance the reproductive return of a female. Therefore, the return of being risky is often higher for males. However, being risky also comes with a cost, i.e., the higher mortality. Risky-behavior is, of course, life-threatening and raises mortality (Wilson and Daly, 1985; Kruger and Nesse, 2006; Phillips, 2006; Kraus, Eberle and Kappeler, 2008).

Consequently, physiological and behavioral differences as well as the life expectancy gap can be interpreted as different aspects of sexual dimorphism, indicating that sexual selection is the fundamental cause of the life expectancy gap. Nevertheless, it varies with the surrounding environment. Therefore, the surrounding environment and resulting behavioral aspects need to be taken into account to examine the explanatory power of happiness on the life expectancy gap.

3 Regression Strategies

3.1 Happiness data

Happiness data used in this study are taken from the European and World Values Surveys, wave 1 (1981-84), 2 (1989-93), 3 (1994-99) and 4 (1999-2004). Among various questions, respondents are asked about the feeling of happiness. Following the statement, "Taking all things together, would you say you are...," they are asked to choose one from "Very happy (4)", "Quite happy (3)", "Not very happy (2)", and "Not at all happy (1)."

As the data are subjective, there are concerns whether the data satisfy the basic objectiveness that are crucial for comparative studies. Common issues include whether questioners are not influencing respondents' answers or whether wording is neutral. In addition, when the data are used at aggregate level across cultures and periods, other issues arise, such as whether respondents can correspond to the entire population or whether the definition of happiness is the same across societies and periods.

Despite these issues, happiness data have been used in a number of studies in various disciplines, including sociology, psychology, economics, political science, and demography, and provided meaningful insights in these fields. Following these literatures, this study utilizes happiness data, but with caution.

To construct the variables for regression analyses, the national average of happiness, HP, and the difference in happiness level between women and men, $HPGAP$, are calculated for each country in each wave (country-wave). The number of respondents is, on average, 1,380 (717 women and 663 men) per country-wave that at least contains the data with regard to age, sex, marital status (which can be separated into the married, the separated or divorced, the widowed, and the never married), and happiness. The maximum is 4,599 (2,297 women and 2,302 men) in Turkey (wave 4), and the minimum 303 (164 women and 128 men) in Malta (wave 1). The number of countries included in each wave are respectively 19 (wave 1), 43 (wave 2), 54 (wave 3), and 68 (wave 4).

The average as well as marital-status specific figures are presented in Table 1.[2] It indicates that happiness level varies with marital status. In particular, loosing one's spouse has a significant negative impact on happiness. It also shows that, while the happiness gap is almost negligible on average, the gap is larger at each marital-status category. This suggests the existence of the compositional effect. Besides, this result indicates the possibility that the sex gap in happiness has been underestimated. Although it has been routinely ignored since the average sex gap is so small, the difference may not be as small as calling it negligible after controlling for marital status.

Place Table 1 around here

3.2 Simultaneous causality

As discussed earlier, there is a good reason to suspect the existence of the reverse causality that runs from the life expectancy gap, $LEGAP$, to HP and $HPGAP$. The intermediary is the composition of marital status. The level of happiness differs with marital status, and at the same time, $LEGAP$

[2]These values are the averages of the country-wave. The observations with less than five respondents in either sex in any marital status are omitted.

is expected to influence the composition of marital status by changing the widowhood ratio. Thus, $LEGAP$ is expected to affect HP and $HPGAP$ indirectly through the composition of marital status. The correlation between $LEGAP$ and the widowhood ratio is presented in Figure 1. As expected, they seem to be positively correlated, indicating that a larger $LEGAP$ raises the chance of widowhood for women.[3]

Place Figure 1 around here

Next, the correlation between the widowhood ratio and $HPGAP$ is presented in Figure 2. It shows that they are negatively correlated. As the widowhood ratio increases, women become less happy relative to men.[4] This is consistent with the finding that loosing one's spouse has a substantial negative effect on happiness in Table 1.

Place Figure 2 around here

Connecting these relationships together suggests that $LEGAP$ negatively affects women's average happiness, and consequently, reduces HP and $HPGAP$. Figure 3 presents this relationship. It shows that $LEGAP$ is negatively correlated with $HPGAP$. This effect is clear for $HPGAP$, whereas its effect on HP is not visible.

Place Figure 3 around here

This reverse causality is further confirmed with the relationship between $LEGAP$ and marital-status-specific happiness values. As presented in Table 2, the correlation coefficients between $LEGAP$ and each of marital-status-specific happiness gap are much smaller than the coefficient between $LEGAP$ and the average. For example, while the correlation coefficient between $LEGAP$ and the average happiness gap is -0.48, the corresponding figure for the widowed is -0.11. The same thing can be said to happiness itself. By decomposing happiness by marital statuses, the correlation coefficients between $LEGAP$ and each of marital-status-specific figures become smaller. These results suggest the existence of the compositional effect. Therefore, the reverse causality needs to be controlled explicitly in the regression analyses.

Place Table 2 around here

[3] To a lesser extent, the life expectancy gap also increases the chance of being widowed for men. This is probably because a larger life expectancy gap is associated with a less rectangular survival curve for both sexes.

[4] It would be worrying for married men if the causality runs the opposite direction.

3.3 Explanatory variables

Explanatory variables include women's labor force ratio, LR, the log of purchasing-power-parity adjusted per-capita GDP, $LYPC$, hospital beds per 1.000 people, HB, physicians per 1.000 people, PH, fertility rate, FT, and the level of life expectancy for both sexes, LE.

LR is included to capture the importance of life style. However, the expected sign of LR is not certain. On one hand, a higher LR may indicate a greater autonomy in women, and thus, may raise women's life expectancy (a larger $LEGAP$). On the other hand, a higher LR may imply less healthy lifestyle as women's life style becomes similar to men's, and thus, may lower women's life expectancy (a smaller $LEGAP$).

$LYPC$, HB, and PH are included to capture the effects of economic and medical resources. As women tend to utilize economic and medical resources more for their health, the variations in these variables may be more influential on women's life expectancy than men's life expectancy, and thus, may positively affect $LEGAP$.

FT and LE represent the country's demographic characteristics. FT is included to capture the risk of giving birth, and thus, FT is expected to affect $LEGAP$ negatively. The expect effect of LE is also negative. As LE rises, $LEGAP$ tends to shrink in countries where life expectancy is relatively high. One possible explanation for this phenomenon is given by Glei and Horiuchi (2007) that the same rate of mortality decline produces smaller gains in life expectancy for women than for men because women's deaths are less dispersed across age as life expectancy becomes high.

On top of these variables, instrumental variables are necessary. The simultaneous causality pointed out in the previous subsection makes OLS inappropriate and proper instruments are required to apply 2SLS.

The most prominent choice of instruments is a set of marital-status-specific happiness variables. After controlling for marital status, the effects of $LEGAP$ on HP and $HPGAP$ should be substantially reduced. Among four types of marital-status-specific happiness variables, the ones for the widowed, HPW and $HPGAPW$, are expected to be the best instruments since the individuals in this category have already gone through the hardship of being widowed and $LEGAP$ should not have any further impact on them.[5] On the other hand, happiness variables in other marital statuses could be influenced by $LEGAP$ since $LEGAP$ affects the expectation with respect to the chance of being widowed in the future.

However, there are two drawbacks for using marital-status-specific happiness variables. First, the number of respondents is small to construct these

[5]Both the average happiness level of the widowed without controlling for the sex difference and the average of the sex-specific happiness levels of widowed women and widowed men are experimented. The results do not differ in any meaningful way, and subsequently, the average happiness of the widowed is employed in the followings.

variables. Even though a survey contains on average about 1,380 respondents in one country, the widowhood ratio is only about 5%. Subsequently, there would be on average only 35 respondents for each sex available for calculating HPW and $HPGAPW$. As a result, the reliability of these variables becomes much lower.[6] Second, the effect of $LEGAP$ may still remain in marital-status-specific happiness variables. For example, Barber (2007) argues that gender-discrimination is associated with life expectancy gap and lowers happiness. In this sense, both life expectancy gap and happiness are the results of a third factor, and thus, using marital-specific happiness variables is not an adequate solution. To avoid these problems and raise the credibility of estimation, other instruments that are not related to marital-specific happiness are also applied.

Later, other explanatory variables are added to test whether the inclusion of these variables affects the results. The reason for initially limiting the number of explanatory variables is to keep the number of observations as high as possible. The newly included variables are the sex difference in smoking rate between women and men, $SMGAP$, the sex difference in education (average years of schooling) between women and men, $EDGAP$, and the Gini coefficient, $GINI$.

The expected sign of $SMGAP$ is negative. As women's smoking rate increases relative to men's, $LEGAP$ is expected to narrow. Although this is considered to be a very important factor, it is excluded in the earlier part because the data covers only European and former Soviet Asian countries.

$EDGAP$ is expected to affect $LEGAP$ positively as education lowers mortality. Thus, as women obtain more education relative to men, $LEGAP$ is expected to rise. However, the causality runs both directions. As individuals are expected to live longer, they obtain more education. Thus, $EDGAP$ is included with and without instruments.

$GINI$ is incorporated to test the effect of inequality. As inequality increases, mortality rates of the rich and the poor are expected to diverge. In particular, life expectancy of the poor is expected to be more elastic to income than life expectancy of the rich. As a result, if being poor is more influential to women's survival, as economic resources are more important for women's life expectancy, a larger $GINI$ is expected to decrease $LEGAP$ by lowering women's life expectancy more significantly. However, on the other hand, if being poor in a country leads to greater stress and this effect is not captured by either HP or $HPGAP$, it can affect $LEGAP$ positively by lowering men's life expectancy more intensely.

The sample size becomes only 33 if all variables are included at the same time. Thus, they are regressed separately at first, and later, regressed all together.

[6] To keep the data reliable, the observations with less than 5 respondents in either sex of the marital status that is under consideration are omitted in the analyses.

3.4 Methods

The data set is the four-period panel with 142 observations (69 countries) when the variables for the widowed are used. For cross-country panels, a common method of estimation is to apply the fixed-effect model with country dummies. In this way, country dummies capture the unobservable country-specific effects. However, the present panel data set is heavily unbalanced. Only three countries (Spain, Sweden, and the U.S.) have full observations and 23 countries have only one observation. This implies that applying the fixed-effect model with country dummies is not realistic. Therefore, the data set is treated as a pooled data set. Instead, subregional dummies are included. This indicates that the model can be regarded as the fixed-effect model with subregion-specific constant. The region with only one observation is omitted. On this data set, the effects of HP and $HPGAP$ are estimated with 2SLS.

4 Regression Results

4.1 Reverse Causality

Before regressing $LEGAP$, HP and $HPGAP$ are respectively regressed on $LEGAP$ together with HPW and $HPGAPW$. This is to estimate the significance of the reverse causality discussed in the previous section. HPW and $HPGAPW$ are included to capture the country's basic levels of happiness and happiness gap which are independent of the compositional change in marital status. $LEGAP$ is incorporated to catch the compositional effect of marital status. In other words, HP and $HPGAP$ are decomposed into the two components; the country's basic levels and the compositional effects of marital status due to the life expectancy gap, and their effects are separately estimated.

Table 3 presents the results. The top figures are the estimated coefficients, and the bottom figures are the heteroskedasticity-robust t-statistics. It indicates that $LEGAP$ negatively affects both HP and $HPGAP$. The levels of significance are respectively 5% and 1%. The inclusion of regional dummies and periods dummies does not change the results. These results support the existence of the reverse causality.

Place Table 3 around here

4.2 Model specification

Table 4 presents the regression results on $LEGAP$. Equations (1) and (2) are estimated for model-specification. As HB captures the effect of medical resources better than PH, HB is kept as a proxy for medical resources in the followings. Omitting PH increases the number of observations.

Place Table 4 around here

The period dummies which are incorporated to capture time trend are insignificant. They are never significant at the 10% level. In addition, regressing with only 4th-period sample, the period with the most number of observations, yields similar results as the pooled estimates as indicated in equation (2). For these reasons, the period dummies are omitted in the following regression analyses. This would also reduce the possibility of having biased estimates.

4.3 Happiness gap: $HPGAP$

Equation (3) presents the results without PH and period dummies. It indicates that $HPGAP$ is not significant. One possible reason for this result is the weak explanatory power of instruments. In particular, the explanatory power of $HPGAPW$ is not very strong. Shea's Partial R^2 for $HPGAP$ is 0.066 whereas it is 0.467 for HP (Shea, 1997). Excluding regional dummies does not change the result as in equation 4.

Nevertheless, it is interesting to compare this result with equation (5) in which the equation is regressed with OLS. Although $HPGAP$ is insignificant with 2SLS, its coefficient becomes significantly negative with OLS as oppose to the expected sign. This illustrates the significance of the reverse causality discussed in the previous section. The OLS estimate captures the effect of $LEGAP$ on $HPGAP$, and consequently, is considered to be a biased estimate.

Using happiness variables of other marital status for instruments does not improve the results. As shown in equation (6), using happiness variables of the married yield the results similar to the OLS results, This indicates the existence of reverse causality among the married. The higher possibility of being widowed in the future seems to be affecting their happiness level. This reserve causality is not detected with the separated or divorced or the never married as shown in equations (7) and (8), but it does not change the significance of $HPGAP$ in any meaningful way.

In summary, the explanatory power of $HPGAP$ on $LEGAP$ is not confirmed with aggregate data set at this moment. Subsequently, $HPGAP$ is omitted in the following analyses.

4.4 Happiness: HP

Equations (9) - (12) show the results without $HPGAP$. Equation (10) presents the results with OLS. Equations (9), (11), and (12) are with instruments respectively with HPW, the price level of investment, PI, and both HPW and PI.[7] The coefficients of HP are significantly negative at the 1% level in all equations. The validity of instruments are supported by the statistics from the first-stage regressions with under-identification, weak-identification, and over-identification tests (Hansen, 1982; Stock and Yogo, 2005; Kleibergen and Paap, 2006).

The choice of instruments affects the value of coefficients. With OLS, the estimated value is -2.76 while the 2SLS estimate is respectively -3.26, -4.40, or -3.32. However, these differences are not statistically significant. Thus, at this moment, it can be summarized that the increase in aggregate happiness level by 0.1 point would lower life expectancy gap by 0.3 to 0.4 years.

Turning to other variables, the results are consistent with the prediction. The coefficients of LE and FT are significantly negative and the coefficients of $LYPC$ and HB are significantly positive. As for LR, the positive effect of women's autonomy seems to be more substantial.

4.5 Robustness

Next, other explanatory variables are incorporated. Although doing this reduces the sample size, it allows to test the robustness of the results obtained in the previous subsection.

First, the smoking gap is added in equation (13). As expected, $SMGAP$ affects $LEGAP$ negatively. As women smoke more relative to men, women's advantage in life expectancy shrinks. Instead, FT and HB lose explanatory powers. This can possibly be due to the inclusion of $SMGAP$, or due to the change in the sample characteristics. As the smoking data set covers only European and former Soviet Asian countries, the sample countries are more homogeneous. In particular, many developing countries with low level of medical resources are excluded. This may be the cause that FT and HB become insignificant. On the other hand, turning to HP, it is still significant at the 5% level, supporting the hypothesis.

In equations (14) and (15), the education gap is added. As discussed earlier, the relationship between education and life expectancy is expected to be mutual. Thus, equation (14) estimates the coefficients with extra instruments, i.e., general government final consumption expenditure (% of GDP), GC, and physicians per 1.000 people, PH, and equations (15) without extra instruments. In both cases, the explanatory power of $EDGAP$ on life expectancy is extracted at the 1% level of significance. The inclusion of $EDGAP$, on the other hand, lowers the significance level of HP, but it is still significant at the 10% level.

The Gini coefficient is included in equation (16). As the sample size becomes much smaller and multicollinearity becomes severe, regional dummies

[7] A number of economic variables are examined, and using PI only seems to yield the best fit.

are dropped. Although the significance of $GINI$ can not be confirmed even at the 10% level, the inclusion of $GINI$ does not affect the significance of HP.

Finally, all the variables are included at the same time in equations (17) and (18). The presented equations are the results without the extra instruments, GC and PH, to control for the endogenuity of $EDGAP$. Using additional instruments does not affect the results in any meaningful way. Although the results must be interpreted with caution as the sample size is small, it still rejects the null hypothesis that HP is not different from zero at the 5% level of significance.

These results support the importance of HP on explaining $LEGAP$. As happiness increases at the national level, the life expectancy gap between women and men shrinks.

5 Concluding Remarks

This study aims to examine the effects of happiness on life expectancy. Using the sex difference in life expectancy instead of the level itself, it demonstrates that happiness is significant on explaining the differences in the life expectancy gap between countries. As national average happiness increases, the sex difference in life expectancy decreases. This is consistent with the findings that psychological stress (unhappiness) adversely affects survival and that the effect of psychological stress on mortality is more severe for men. This result provides an indirect evidence that happiness affects life expectancy even at national aggregate level.

By analyzing the relationship between happiness and life expectancy, this study also reveals that the relationship between national happiness and the life expectancy gap is not unidirectional. While happiness affects the life expectancy gap, the life expectancy gap also influences national average happiness indirectly through the composition of marital status.

This indicates that happiness and life expectancy need to be examined in various perspectives. Biological factors, such as stress responsiveness, and social factors, such as the composition of marital status and the availability of economic resources, are both correlated with happiness and life expectancy. For example, the regression analyses in the present study show that OLS estimates are biased when the life expectancy gap is regressed on happiness. Although incorporating various factors makes the analyses more complex, ignoring them possibly yields misleading results. Better understandings of happiness and health are crucial to facilitate appropriate policy implementation which benefits all human kinds.

A Data Description

A.1 Definitions of variables

HP: National average happiness (European and World Value Surveys, 2008)

$HPGAP$: The difference of the sex-specific average happiness between women and men (European and World Value Surveys, 2008)

HPM, HPD, HPW, HPN: Average happiness respectively for the married, the separated or divorced, the widowed, and the never married. The observations with less than five respondents in either sex of the marital status that is under consideration are omitted. (European and World Value Surveys, 2008)

$HPGAPM$, $HPGAPD$, $HPGAPW$, $HPGAPN$: The difference of the sex-specific average happiness between women and men respectively for the married, the separated or divorced, the widowed, and the never married. The observations with less than five respondents in either sex of the marital status that is under consideration are omitted. (European and World Value Surveys, 2008)

LE: Life expectancy for both sexes (UN, 2008)

$LEGAP$: The difference of life expectancy between women and men (UN, 2008)

$LYPC$: GDP per capita (purchasing-power-parity adjusted) (Penn World Table 6.2, 2008)

PI: Price level of investment (Penn World Table 6.2, 2008)

FT: Fertility rate (births per woman) (World Bank, 2008)

HB: Hospital beds per 1.000 people (World Bank, 2008)

PH: Physicians per 1.000 people (World Bank, 2008)

GC: General government final consumption expenditure (% of GDP) (World Bank, 2008)

$SMGAP$: The difference of smoking rate between women and men (WHO Europe, 2007)

$EDGAP$: The difference of average years of schooling between women and men for those age 25 and above (Barro and Lee, 2008)

$GINI$: GINI coefficient (LIS, 2008)

Regional Dummies: The separation follows the subregions defined by UN. However, considering their cultural aspects and making the number of observations in each region sufficiently large, the following subregions are integrated together. Caribbean and Central and South America; North America and Australia and New Zealand; Eastern, Southern, Middle, and Western Africa; Central and Western Asia and Northern Africa.

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A.3 Sample periods

The sample periods consist of four periods, 1980-1984 (1), 1990-1994 (2), 1995-1999 (3), and 2000-2004 (4). This follows the sample periods of the dependent variable, $LEGAP$. Happiness data are attached to these periods according to wave number. As for the varialbes from PWT, LIS, and World Bank, the averages are taken for each variables within each period. As for $EDGAP$, although the data are presented in every five years such as 1980, 1990, and 1995, the newest data are in 1999. Thus, the data in 1999 are used for the forth period.

A.4 Sample countries and sample periods

Equations (3 to 5, and 9 to 12): Albania (3, 4), Algeria (4), Azerbaijan (3), Argentina (2, 3, 4), Australia (1, 3), Austria (2, 4), Bangladesh (3), Armenia (3), Belgium (1, 2, 4), Bosnia and Herzegovina (3, 4), Brazil (2, 3), Belarus (3, 4), Canada (1, 2, 4), Chile (2, 3, 4), China (2, 3, 4), Colombia (3), Croatia (3, 4), Czech Republic (2, 4), Denmark (1, 2, 4), El Salvador (3), Estonia (2, 3, 4), Finland (2, 3, 4), France (1, 2, 4), Georgia (3), Germany (2, 3, 4), Greece (4), Hungary (2, 3, 4), Iceland (1, 4), India (2, 4), Ireland (1, 2, 4), Italy (1, 2, 4), Japan (1, 3, 4), Jordan (4), Republic of Korea (3), Kyrgyzstan (4), Latvia (3, 4), Lithuania (2, 3, 4), Luxembourg (4), Malta (1, 4), Mexico (2, 3, 4), Republic of Moldova (3, 4), Morocco (4), Netherlands (2, 4), New Zealand (3), Norway (2, 3), Pakistan (4), Peru (3), Philippines (4), Poland (2, 3, 4), Portugal (2, 4), Puerto rico (3), Romania (2, 3, 4), Russia (2, 3, 4), Singapore (4), Slovakia (2, 3, 4), Vietnam (4), Slovenia (2, 3, 4), Spain (1, 2, 3, 4), Sweden (1, 2, 3, 4), Switzerland (2), Turkey (2, 3, 4), Ukraine (2, 3), Macedonia (3, 4), Egypt (4), UK (1, 2, 3), US (1, 2, 3, 4), Uruguay (3), Venezuela (3, 4).

Equation (13): Albania (4), Austria (2), Armenia (3), Belgium (1, 2, 4), Bosnia and Herzegovina (4), Belarus (3, 4), Croatia (3, 4), Czech Republic (2, 4), Denmark (2, 4), Estonia (2, 3, 4), Finland (2, 3, 4), France (1, 2, 4), Georgia (3), Germany (3, 4), Greece (4), Hungary (2, 3, 4), Iceland (4), Ireland (1, 2, 4), Italy (2, 4), Kyrgyzstan (4), Latvia (3, 4), Lithuania (2, 3, 4), Luxembourg (4), Malta (4), Republic of Moldova (1), Netherlands (2, 4), Norway (2, 3), Poland (2, 3, 4), Portugal (2), Romania (2, 4), Russia (2, 3, 4), Slovakia (2, 3), Slovenia (2, 3, 4), Spain (2, 3, 4), Sweden (1, 2, 3, 4), Switzerland (2), Turkey (4), Ukraine (3, 4), macedonia (3), UK (1, 2, 3).

Equations (14, 15): Algeria (4), Argentina (2, 3, 4), Australia (1, 3), Austria (2, 4), Bangladesh (3), Belgium (1, 2, 4), Brazil (2, 3), Canada (1, 2, 4), Chile (2, 3, 4), China (2, 3, 4), Colombia (3), Denmark (1, 2, 4), El Salvador (3), Finland (2, 3, 4), France (1, 2, 4), Germany (2, 3, 4), Greece (4), Hungary (2, 3, 4), Iceland (1, 4), India (2, 4), Ireland (1, 2, 4), Italy (1, 2, 4), Japan (1, 3, 4), Jordan (4), Republic of Korea (3), Malta (1, 4), Mexico (2, 3, 4), Netherlands (2, 4), New Zealand (3), Norway (2, 3), Pakistan (4), Peru (3), Philippines (4), Poland (2, 3, 4), Portugal (2, 4), Singapore (4), Spain (1, 2, 3, 4), Sweden (1, 2, 3, 4), Switzerland (2), Turkey (2, 3, 4), Egypt (4), UK (1, 2, 3), US (1, 2, 3, 4), Uruguay (3), Venezuela (3, 4).

Equation (16): Australia (1, 3), Austria (2, 4), Belgium (2, 4), Canada (1, 2, 4), Czech Republic (2), Denmark (2, 4), Estonia (4), Finland (2, 3, 4), France (1, 2, 4), Germany (2, 4), Greece (4), Hungary (2, 3), Ireland (2, 4), Italy (2, 4), Luxembourg (4), Mexico (2, 3, 4), Netherlands (2), Norway (2, 3), Poland (2, 3), Romania (3), Russia (2, 3, 4), Slovakia (2, 3), Slovenia (3), Spain (1, 2, 3, 4), Sweden (1, 2, 3, 4), UK (2, 3), US (2, 3, 4),

Equations (17, 18): Austria (2), Belgium (2, 4), Denmark (2, 4), Finland (2, 3, 4), France (1, 2, 4), Germany (4), Greece (4), Hungary (2, 3), Ireland

(2, 4), Italy (2, 4), Netherlands (2), Norway (2, 3), Poland (2, 3), Spain (2, 3, 4), Sweden (1, 2, 3, 4), UK (2, 3).

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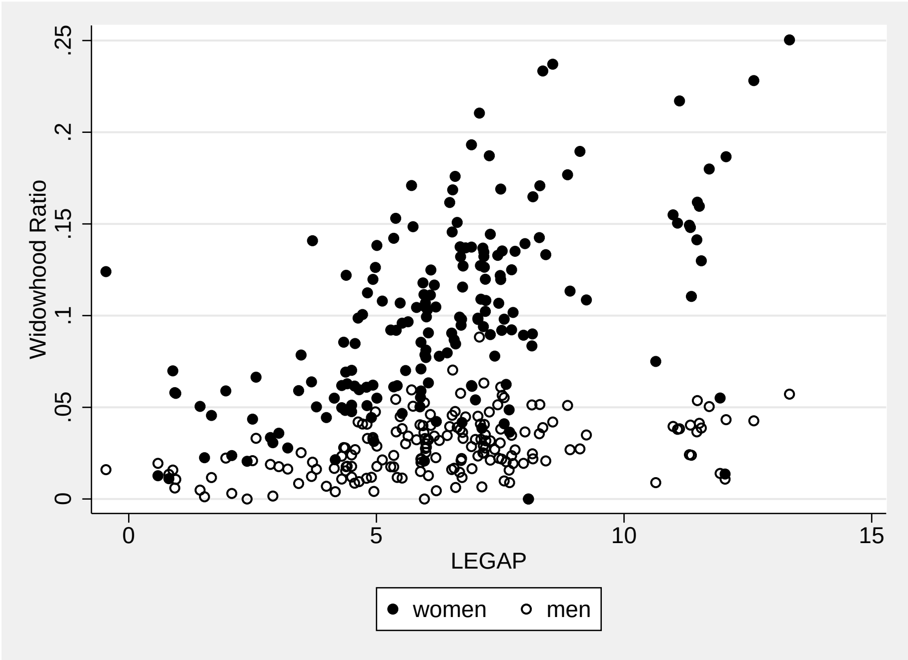

Figure 1: Correlation between Widowhood Ratio and Life Expectancy Gap

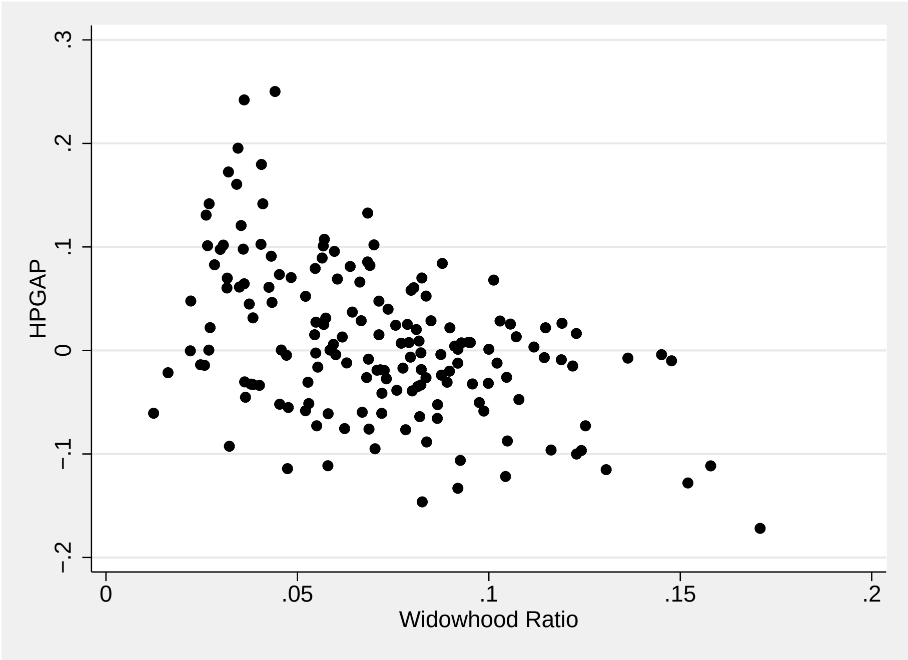

Figure 2: Correlation between Happiness Gap and Widowhood Ratio

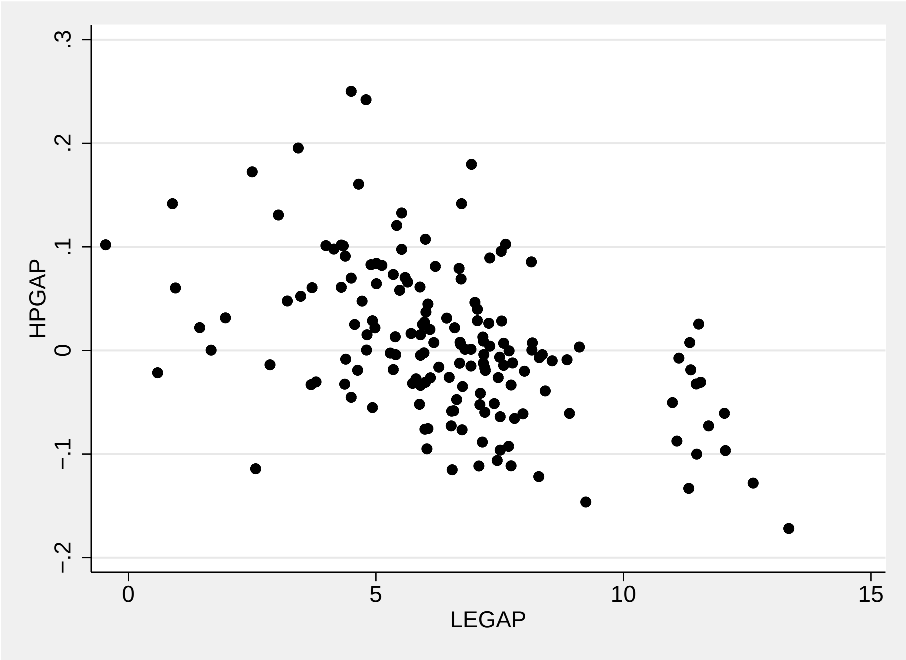

Figure 3: Correlation between Happiness Gap and Life Expectancy Gap

Table 1: Happiness and Happiness Gap

	National Average	Married	Separated or Divorced	Widowed	Never Married
HP	3.02	3.08	2.75	2.76	3.00
HPGAP	0.001	0.028	0.037	0.071	0.037

The number of observations: 144

Table 2: Correlation with *LEGAP*

	National Average	Married	Separated or Divorced	Widowed	Never Married
HP	-0.51	-0.48	-0.44	-0.48	-0.49
HPGAP	-0.48	-0.29	-0.02	-0.11	-0.30

The number of observations: 139

Table 3: Regression Results (Dependent Variable: *HP* and *HPGAP*)

	HPW	*HPGAPW*	*LEGAP*	Dummies Region	Dummies Period	R-sq	obs. #
HP							
(1)	0.681		-0.015	yes	yes	0.89	142
	13.38 ***		-2.31 **				
(2)	0.726		-0.011	no	no	0.86	142
	23.60 ***		-2.42 **				
HPGAP							
(3)		0.068	-0.015	yes	yes	0.49	142
		3.46 ***	-5.50 ***				
(4)		0.082 ***	-0.015	no	no	0.31	142
		3.45	-6.05 ***				

The top figures are the estimated coefficients..
The bottom ones are heteroskedasticity-robustt t-statistics.
***, **, and * respectively indicate the significance level at p<0.01, p<0.05, and p<0.10.

Table 4: Regression Results (Dependent Variable: *LEGAP*)

	Method Instruments	*HP*	*HPGAP*	*LE*	*LYPC*	*FT*	*LR*	*HB*	*PH*	*SMGAP*	*EDGAP*	*GINI*	Dummies Region	 Period	Under-ID Test	Weak-ID Test	Over-ID Test	R-sq	obs. #
(1)	2SLS	-3.216	2.722	-0.391	1.601	-1.004	0.0499	0.166	0.1959				yes	yes	8.08	3.80		0.81	135
	HPW / HPGAPW	-3.71 ***	0.39	-5.40 ***	4.77 ***	-2.33 **	1.63	3.10 ***	0.79						0.00	7.03			
(2)	2SLS	-3.628	3.013	-0.394	1.455	-0.283	0.0960	0.364	0.0326				yes	no	2.18	0.72		0.87	51
	HPW / HPGAPW	-2.96 ***	0.26	-2.07 **	2.12 **	-0.65	1.26	2.72 ***	0.07						0.14	7.03			
(3)	2SLS	-3.405	2.031	-0.359	1.632	-1.060	0.0611	0.147					yes	no	8.56	4.41		0.80	142
	HPW / HPGAPW	-3.93 ***	0.30	-5.15 ***	5.01 ***	-2.55 **	2.22 **	3.61 ***							0.00	7.03			
(4)	2SLS	-4.664	8.667	-0.300	2.028	-0.619	0.0984	0.063					no	no	6.58	3.55		0.49	142
	HPW / HPGAPW	-2.69 ***	0.95	-3.94 ***	3.83 ***	-1.33	3.13 ***	1.09							0.01	7.03			
(5)	OLS	-2.774	-3.224	-0.325	1.461	-0.940	0.0475	0.150					yes	no				0.82	142
		-4.89 ***	-2.01 **	-6.46 ***	5.69 ***	-2.87 ***	2.21 **	3.47 ***											
(6)	2SLS	-3.196	-2.933	-0.341	1.650	-1.058	0.0294	0.130					yes	no	32.28	202.97		0.83	150
	HPM / HPGAPM	-5.62 ***	-1.71 *	-6.74 ***	6.23 ***	-3.59 ***	1.40	3.55 ***							0.00	7.03			
(7)	2SLS	-1.942	6.222	-0.554	2.128	-1.925	0.0432	0.136					yes	no	7.80	5.58		0.79	142
	HPD / HPGAPD	-1.62	0.81	-3.57 ***	5.13 ***	-3.64 ***	1.12	3.61 ***							0.01	7.03			
(8)	2SLS	-2.507	0.267	-0.402	1.686	-1.220	0.0410	0.133					yes	no	23.44	18.64		0.83	156
	HPN / HPGAPN	-4.24 ***	0.09	-6.62 ***	6.17 ***	-3.85 ***	1.90 *	3.60 ***							0.00	7.03			
(9)	2SLS	-3.259		-0.343	1.576	-1.004	0.0553	0.147					yes	no	38.46	158.86		0.81	142
	HPW	-4.71 ***		-6.98 ***	5.97 ***	-3.03 ***	2.64 ***	3.57 ***							0.00	16.38			
(10)	OLS	-2.759		-0.357	1.525	-1.055	0.0579	0.153					yes	no				0.81	142
		-4.75 ***		-7.34 ***	5.94 ***	-3.13 ***	2.81 ***	3.63 ***											
(11)	2SLS	-4.398		-0.312	1.691	-0.888	0.0494	0.134					yes	no	9.56	15.95		0.80	142
	PI	-3.10 ***		-5.50 ***	5.41 ***	-2.39 **	2.27 **	3.12 ***							0.00	16.38			
(12)	2SLS	-3.322		-0.341	1.582	-0.998	0.0550	0.147					yes	no	38.74	84.25	0.87	0.81	142
	HPW / PI	-4.84 ***		-6.97 ***	6.00 ***	-3.01 ***	2.63 ***	3.56 ***							0.00	19.93	0.35		
(13)	2SLS	-2.521		-0.356	1.471	-0.680	0.0572	0.037		-0.0535			yes	no	14.66	48.71		0.86	79
	HPW	-2.59 **		-5.50 ***	3.90 ***	-1.55	2.14 **	1.03		-3.21 ***					0.00	16.38			
(14)	2SLS	-1.531		-0.297	1.482	-0.613	0.0331	0.093			1.251		yes	no	7.60	2.54	1.63	0.80	93
	HPW / GC / PH	-1.87 *		-4.20 ***	3.06 ***	-1.77 *	0.94	2.49 **			3.24 ***				0.02	13.43	0.20		
(15)	2SLS	-1.334		-0.264	1.531	-0.403	0.0303	0.103			0.777		yes	no	20.19	60.85		0.82	98
	HPW	-1.72 *		-4.90 ***	3.39 ***	-1.37	1.11	2.96 ***			5.45 ***				0.00	16.38			
(16)	2SLS	-2.452		-0.307	0.724	-0.822	0.0466	0.114				3.32	no	no	12.43	71.62		0.80	57
	HPW	-2.69 ***		-3.37 ***	1.36	-1.51	1.55	1.83 *				1.39			0.00	16.38			
(17)	2SLS	-3.346		-0.262	1.001	0.261	0.0263	0.018		-0.0956	0.917	-7.91	no	no	5.86	6.74		0.80	33
	HPW	-1.77 *		-1.53	0.82	0.28	0.44	0.39		-2.14 **	1.80 *	-1.64			0.02	16.38			
(18)	2SLS	-2.787		-0.193						-0.0837	0.856	-11.00	no	no	9.50	16.67		0.79	33
	HPW	-2.30 **		-4.00 ***						-3.24 ***	2.34 **	-3.14 ***			0.00	16.38			

The top figures are the estimated coefficients., the bottom ones are heteroskedasticity-robustt t-statistics.

***, **, and * respectively indicate the significance level at p<0.01, p<0.05, and p<0.10.

Uunder-ID test: Kleibergen-Paap rk LM statistic at the top, and the corresponding p-value at the bottom (see Kleibergen and Paap, 2006).

Weak-ID test: Kleibergen-Paap rk Wald F statistic at the top, the Stock-Yogo weak ID test critical value for the Cragg-Donald i.i.d. case fort a 10% bias at the bottom (see Kleibergen and Paap, 2006; Stock and Yogo, 2005) .

Over-ID test: Hansen J statistic at the top, the correponding p-value at the bottom Hansen, 1982).